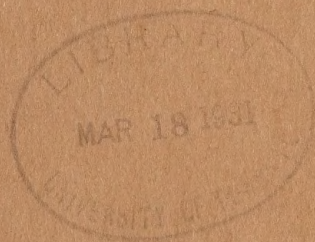


Canada, Mines, Bureau of
Explosives Division

THE HANDLING *of* EXPLOSIVES



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EXPLOSIVES DIVISION
—
DEPARTMENT OF MINES
OTTAWA, CANADA
1931

No. 11

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INTRODUCTORY

The employment of explosives in land clearing is probably the most widely known application of explosives in the Dominion. The great saving of labour and time which is effected by the use of explosives in this work is a matter of common knowledge. Operations are undertaken, as a rule, by the farmers themselves. There is no reason why they should not be, but when it is remembered that farmers, and indeed other occasional users of explosives, have rarely much previous experience in shotfiring, it will be realized that they may expose themselves to very real dangers by failing to exercise those precautions which would be adopted by careful and experienced shotfirers.

Some manufacturers have published manuals in which advice is given as to the most suitable and economical methods of conducting certain operations. Thus, in the discussion of land clearing, consideration is given to the selection of the explosives, to the quantity required, and to the placing of the charge so as to obtain the desired effect, having regard to the nature and size of the stump to be removed. Problems relating to rock work, road construction, irrigation channels, ditching, tree planting and so forth are likewise dealt with. Such manuals, as well as notices sometimes issued with the explosives, also touch on matters that are more vitally important than those relating to efficiency, namely, those relating to safety in the handling of the explosives, and in the preparation and firing of the charge.

The purpose of this pamphlet is to call attention to the cardinal principles which should be observed in the handling of explosives and shotfiring, from the point of view of safety. The questions of the selection of an explosive and the most advantageous manner of its application will not be taken up. If guidance in such points is required, it should be sought from the suppliers of the explosives.

In this connection it is pleasing to note that cases continually come under the observation of inspectors indicative of the assistance and good advice tendered by manufacturers to users of explosives.

The policy of the manufacturer is, naturally, to do what he can towards helping his customers to use his explosives to the best advantage so that it may give satisfaction from the point

of view of efficiency. No one however is more fully aware than he of the dangers which arise from the misuse of explosives, whether due to carelessness or ignorance. Consequently the consideration of safety underlies the advice he gives on technical points, and prompts other counsels in respect to the general handling of the explosives. Dominion and Provincial Government departments interested in agriculture, mining, railways, canals, highways and public works in general, looking to the extension of the area of cultivation, to the progress of their undertakings, or to industrial development, with a full conception of the essential part played by explosives in a multitude of activities, are also cognizant of the frequency of accidents which occur in connection with the use of explosives.

The Explosives Act, with the administration of which this division is concerned, does not, it is true, cover the actual use of explosives. It does apply up to the time at which the shotfirer takes his cartridge, his detonator and his safety fuse from their respective boxes, but that is a minor point. Its keynote is safety, and it is in an endeavour to promote this, and having regard not only to our own observations but to those of others in a position to observe and to appreciate the causes of accidents, and to the universal desire to overcome these as far as may be, that these notes have been prepared.

CONVEYANCE OF EXPLOSIVES

The person who orders a small quantity of explosives for his own use will, in all probability, have to take them over from a railway agent or from a storekeeper. His first consideration should be the manner of their conveyance by road to his own place of storage. Regulations covering this have been published. Attention is here drawn to only a few salient points.

Explosives should be securely stowed in the vehicle so as not to be liable to movement by reason of jolting. Detonators should not be conveyed with dynamite, or stumping powder, on account of their liability to detonation under the influence of an accidental blow and the probability of the dynamite being detonated by influence. No other goods of a dangerous or easily combustible nature, such as matches, oils or gasoline, should be in the same vehicle. The driver should not smoke. He should avoid halts, as far as possible, near occupied buildings, and should keep his load under his own observation at all times until he has deposited the explosives in the magazine or other place of storage assigned to them.

KEEPING OF EXPLOSIVES

The conditions under which explosives should be kept vary according to the quantity involved. In this pamphlet is considered the handling of quantities probably not exceeding ten cases of dynamite and say 2,000 detonators.

Quantities not in excess of 20 pounds weight of blasting cartridges and 200 detonators may be kept by the owner in locked receptacles, the detonators being in one receptacle and the blasting cartridges in another. These should not be kept near one another, and suitable locations should be selected having regard to their liability to be tampered with and to risk from fire.

Usually however it will be a question of storing a few boxes of dynamite, or stumping powder. It should be noted that stumping powder is an explosive in every sense, although less powerful than the usual blasting dynamite, and must always be treated with that care which the handling of all explosives demands.

The explosives should be reasonably secured against theft. This does not mean—having regard particularly to temporary storage—that the building or hut in which they are placed should necessarily be of a very substantial nature. The fact that generally such small stocks as are here considered will be kept near the owner's dwelling house or place of work, and so under good supervision, counts for a great deal. A small hut which could be appropriated as a temporary magazine may be available. Failing this a small frame building could be built or a compartment prepared, with door and lock, in an outhouse or shed, provided that the place selected is dry, that goods of an easily inflammable or otherwise dangerous character are not stored in the building, that there is easy access to the compartment, and that explosives are sufficiently removed from dwelling houses or places of work. If the quantity amounts to ten cases this distance should be 100 yards, although 50 would be a reasonable minimum distance to observe if only the owner's house has to be considered.

If detonators are required in excess of 200, arrangements on the same lines should be made for their separate storage. Whether it is a question of a separate building, or compartment, or receptacle, care should be taken to ensure that the interior is kept thoroughly clean and that nothing is stored or left therein except the explosives. A case should never be opened in a magazine or near other explosives. It should be removed well

clear and opened by means of a hardwood wedge, never with a wrecking tool, screw driver or other steel or iron implement. After removing the required explosive from the case, the cover should be replaced and the case returned to the store.

As it is unlawful, save in certain circumstances specially legislated for, to keep more than 150 pounds of explosive in unlicensed premises, application should be addressed to the Chief Inspector of Explosives, Department of Mines, Ottawa, for a licence to cover the keeping of any larger quantity when such is required. If the arrangements for storage as proposed by the applicant are not considered to be satisfactory, advice will then be given regarding their possible improvement, consistent with the regulations and in keeping with the exigencies of the case.

There are persons who have handled explosives for many years, and, though they have done so frequently in a more or less careless and reckless manner, have not experienced an accident. They have been extremely fortunate. Others have not been equally so, and apart from any question of compliance with regulations, it is well that all users of explosives should endeavour to profit by the lessons furnished by the accidents which have occurred. It is with this in view that a brief record is given later of some of the accidents which occurred in Canada in 1923, and of their causes as far as they have been ascertained.

The regulations to which reference has been made, embody precautionary measures such as have been adopted in all countries where the question has been studied and observed for many years. Their purpose is the protection of the public and of persons conveying, keeping and using explosives. Both in the regulations and in their administration the minimum of expense or inconvenience is called for, consistent with the enforcement of the observance of sane and good practice.

EMPLOYMENT OF EXPLOSIVES

Many of the accidents with explosives can be traced to explosives used by consumers of small quantities. This is probably largely due to ignorance of the properties of the explosives or to careless handling. All users should remember that explosives are made to explode under certain conditions, therefore care should be taken that such conditions arise only when the explosive is placed to do work, and all persons are at a safe distance. Explosion may be brought about by friction, shock or heat.

Friction or shock may be caused by rough or careless handling, such as dropping packages containing explosives, or dragging them about on a gritty floor, or forcing explosives into a hole too small in diameter, or opening cases with metal, or by an accidental blow. Any one of these may cause an explosion and should be avoided.

Heat may cause explosives to explode, hence heat should not be applied directly to cartridges.

In thawing explosives, only properly constructed thawing cans should be used. Boiling water should not be put into the thawing cans. If a regular thawing can is not available, a suitable one can be improvised by employing an ordinary kitchen double boiler, placing warm water in the outer section and the explosive to be thawed in the inner section, the whole of course placed well clear of any fire or stove. A blanket or sacking if wrapped around the boiler will help to retain the heat. The water should not be hotter than can be borne with the wrist without discomfort. Explosives should never be placed around a fire or stove, or directly in hot water, or carried on the person. Such improper methods of thawing have been the cause of explosions and accidents.

When using safety fuse and blasting caps for blasting it is false economy to use too short a length of fuse. Most safety fuses burn at the rate of 30 seconds per foot. A length which will allow plenty of time for everyone to get to a place of safety should be used. A good rule is to use not less than 3 feet. **If a charge does not explode**, the shot hole should not be approached immediately, but an interval of at least one hour allowed. If on cutting an inch or two off the fuse it is found that it had not ignited it may be relit. In the event of a further failure this should not be repeated, but a fresh hole should be bored not less than nine inches from the other, and in a direction which shall not approach it. A charge should then be placed in this hole after testing a piece of the fuse to be used to ascertain if it is in good condition. Before firing this charge, which should detonate the first, the fuse of the misfired shot should be attached by a string to a stake or wooden block to ensure the finding of the detonator in the debris, in case the charge is blown out but not exploded.

Where electric blasting caps are used for blasting, the battery, the blasting machine or other source of electrical energy

should be at a safe distance from the charge, and electrical energy should not be applied before every person is safely under cover.

When handling explosives or blasting caps the operator **should not smoke** or carry "strike anywhere matches" or allow others in the vicinity to do such things. If matches are needed for lighting safety fuses, safety matches, those that strike only on the box, should be employed.

When carrying explosives to the work, the blasting caps must be carried separately from the other explosives. Explosives and blasting caps must never be stored together, they should be kept separate at all times until the cap is needed for making up the charge.

For those who are not accustomed to the use of explosives, or are using them in a haphazard manner, the following **procedure in making up and placing a charge** for a blast may be a useful guide. When about to charge a bored hole with explosives care should be taken to ensure that the hole is of such a diameter as to allow the explosive to pass to the bottom of the hole without having to use force. Its capacity should be adequate for the charge decided to be placed, and no more explosive than required for the charge should be brought to the hole. Before placing any explosive in the hole a wooden rod should be forced to the bottom to ascertain whether there is any obstruction. If the hole is found clear, charging can commence. When charging the hole one cartridge of explosive should be placed in the hole at a time, and carefully pressed to the bottom with a flat-ended, wooden tamping rod. A metal bar must never be used for this purpose, accidents have been caused by such practice. This procedure should be followed until all but the last cartridge is firmly seated in the hole; the last cartridge is to be used as a primer and should be made up when required and not before. In making up the priming cartridge, a pointed piece of hardwood about the size of a lead pencil should be employed and a hole made with it in the cartridge of explosive about two and an eighth inches deep, either in the side or end. If in the end the paper should be opened up, about a quarter of an inch should then be cut off the end of the safety fuse, making a square clean cut either with a sharp knife or fuse pliers, and care taken to avoid loss of powder from the core. The blasting cap should then be placed on the newly cut end of the fuse and the cap pressed on the fuse gently until it comes to rest. It

should not be twisted nor should force be used in pressing it on the fuse. The cap should then be crimped on the fuse with a cap crimper, the crimp being about an eighth of an inch from the open end of the cap. Crimping should never be done with the teeth or with clumsy pliers. This is not only a dangerous practice in itself, but imperfect crimping may be the primary cause of a misfire and give rise to other dangers.

The cap with fuse attached should now be placed in the hole which has been made in the cartridge, and if the hole is in the side, the fuse should be secured by tying it with twine around the cartridge. In this case special care should be taken to ensure that the side-primed cartridge will enter the hole easily. If the hole is in the end, the paper should be tied around the fuse; in either case the fuse and cap must be firmly secured to the explosive and the top of the detonator should not project above the surface of the explosive. The primed cartridge should then be placed in the hole and gently pressed down to the charge already there, the wooden tamping rod being used. The safety fuse should not be cut off until the tamping has been completed. Sand or fine earth may then be put into the hole with one hand, and pressed well down with the wooden tamping rod, the fuse being held clear. When the hole has been filled in this manner the fuse should be cut to desired length, preferably not less than 3 feet.

The next step, the charge being now ready for igniting, should be to send every person to a place of safety. When all are safely away, the man who is to ignite the fuse should shout "FIRE" so as to warn others the blast is about to take place. After igniting the fuse the shotfirer should seek safety and should have plenty of time to do so, remembering that fuse burns 30 seconds per foot, if he has allowed a sufficient length.

If electric blasting caps are used, the leading wires from the blast to the source of current should be in charge of the man connecting the wires to the charge, so that he can make sure of being away from the blast when the current is applied. The firer operating the battery or blasting machine should see that all persons are in a safe place, then shout "FIRE" and explode the charge.

If rocks are being broken by placing explosives on them, care should be taken that the explosive is completely covered with clay or fine earth. Rocks or stones should never be used for this purpose as they will be violently projected and may cause accidents.

Before leaving any work on which explosives have been used, a careful check should be made of the explosives and caps to ensure that nothing of an explosive nature is left behind. Carelessness in leaving explosives lying around is undoubtedly responsible for many serious accidents which have befallen both children and adults.

It should be realized that there is little danger if explosives are handled carefully, but great danger if they are handled roughly.

Rough handling can easily be avoided, and if attention be paid to this and to the proper manipulation of explosives, operations can be conducted without loss of time and with great gain in safety.

ACCIDENTS

A classified record of all known accidents with explosives in Canada is given in the Annual Reports of the Explosives Division. A study of these shows that each year the great majority could be placed in two broad categories; one including accidents arising from playing with explosives which had fallen into the hands of persons ignorant of their properties; the other including accidents directly connected with shotfiring.

The former are in the main made possible by the lack of precaution on the part of the rightful owners or users of the explosives to keep them in proper security. This aspect of the question has already been dealt with in the pamphlet "Explosives—Warning" issued in September, 1923, and need not be further referred to here.

The latter are incidental to the use of explosives for their designed purposes. Frequently the evidence of the circumstances of the accidents is insufficient to justify a definite conclusion being drawn as to their causes. Often however the cause is clearly indicated. The accident may have been brought about by some attendant circumstance or condition which the shotfirer could not have foreseen; it is unquestionable that too frequently accidents are brought about by neglect to follow careful practice as that described in the preceding section.

In illustration of the importance of certain precautions in the manipulation of charges a few typical examples may be selected from the accidents in the Dominion in 1923, which were experienced in blasting operations.

Accidents such as those arising from using "too short a fuse," "returning to the shot hole," and "not taking sufficient cover," are relatively frequent.

Storage. Cases of dynamite were temporarily stored in a small wooden building near a boiler house. The ashes from the latter were thrown out and set fire to the shed. One man was seriously injured by the explosion which followed.

Conveyance. Blasting cartridges and detonators were being conveyed by two men in a mine. Initial cause of explosion not known, but it may be presumed that the explosion of the load of cartridges on the trolley was induced by that of the detonators. Both men were killed and considerable material damage done.

Preparing Charges. A miner was injured by the explosion of a detonator when he was pushing the fuse into it.

Smoking. Men of a work party were smoking in a shack in which was an open box containing dynamite cartridges, some with detonator and fuse ready for charging. A fuse was accidentally ignited, and though all endeavoured to run clear three were injured and much material damage done to buildings.

Sparks or Flame. A shotfirer laid a partially filled box of detonators on the ground near the open door of a blacksmith's shop while he was fixing fuses in others. The detonators in the box were exploded, apparently by a spark from the forge alighting on them. Three men were injured.

Flame. A miner approached an unexploded charge with an acetylene lamp and an explosion followed, killing one man and seriously injuring another.

Short Fuse. A man was observed to prime a dynamite cartridge with detonator and fuse estimated at about 12 inches in length intending to light it and throw in on the ice. It apparently did not ignite and he cut off a portion of it and again lit it. The cartridge exploded in his hand. He was badly maimed and died in a few hours.

A man used a fuse, admittedly somewhat less than 3 feet, in a charge placed for blowing a pole hole. He lit it, but no explosion following, he returned to the shot hole and made two or more attempts to light the fuse, cutting off pieces each time.

After he succeeded in starting the fuse to his satisfaction he was unable to get sufficiently clear and was seriously injured by the blast.

Three shotfirers on road work set off seven charges with two-foot fuses. One of the men evidently had difficulty in igniting his fuse and was delayed so that he failed to get clear of the blasts. He lost a leg, had a shoulder dislocated, and suffered from other injuries.

Ramming or Stemming. A quarryman brought about an explosion of a dynamite charge by ramming it with an iron tamping rod. He was seriously injured.

Two men were killed and one injured by the explosion of a charge when it was being rammed home, most probably due to the breaking of the cartridge and the presence of grit, the loose dynamite being exploded by friction.

Returning to Shot Hole. A farmer, blasting stone on his farm, thought a charge which he had ignited had failed and returned to the shot hole. The charge exploded and he sustained severe injuries, including the loss of an eye. The other eye was also affected.

A farmer engaged in blasting a ledge in his orchard, thinking the fuse had not been properly lit, returned to the shot hole to relight it. The charge exploded killing him and injuring his sister who was nearby.

A man working with a lumber tracklaying gang lit the fuses of three shots. On hearing two explosions he returned to investigate the third charge which then exploded, killing him.

A well digger, when a blast did not shoot as soon as he expected, returned to investigate the cause. The explosion then occurred and he sustained severe injuries.

NOT TAKING SUFFICIENT COVER

A logger blowing stumps, took cover behind a nearby tree and was killed by a piece of the stump which rebounded from a tree behind him.

A miner who did not take the prescribed protection on firing a charge was injured on head and arms by projected debris.

DO ONE THING at a time and do it right.

—++++—

DON'T skimp the fuse.

—++++—

DON'T tamper with misfires.

—++++—

A DETONATOR is designed to detonate a blasting cartridge. Keep them separate till you are ready to place the charge.

—++++—

DON'T crimp with your teeth. It's not a visit to the dentist you are risking.

—++++—

DON'T smoke when handling explosives. If you do wish to give up smoking try a less drastic measure.

—++++—

TAKE good cover from projected debris. Don't emulate the legendary ostrich, you may get it in the neck.
